

Appl. No. 09/845,513

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IN THE CLAIMS:

5/01/00

Please add claims 4-18, the full set of claims to read as follows:

6T
1. (Original) An oxygen sensor analyzer for use in testing the performance of an oxygen sensor comprising a portion of a vehicle emission system having an on-board computer, said oxygen sensor analyzer comprising:

a housing having a keypad, said keypad having a plurality of keys and indicator lights disposed thereon; and

a plurality of modes of operation, comprising:

a closed loop oxygen sensor monitor mode, for showing, in real time, the dynamic operation of the oxygen sensor being tested;

a simulated oxygen sensor mode, for simulating oxygen sensor signals to the vehicle computer, while monitoring the oxygen sensor for its reaction to the simulation; and

a oxygen sensor test mode, for performing an oxygen sensor test which forces the engine to run lean without the need for injecting propane thereinto.

6T
2. (Original) A portable oxygen sensor analyzer for use in testing the performance of an oxygen sensor comprising a portion of a vehicle emission system having an on-board computer, said oxygen sensor analyzer comprising:

a housing having a keypad, said keypad having a plurality of keys and indicator lights disposed thereon; and

means for evaluating said oxygen sensor's performance relative to pre-established acceptable standards;

wherein said portable oxygen sensor analyzer is connectable in series with said oxygen sensor and said on-board

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computer, such that said analyzer may be operated while connected within a passenger compartment of said vehicle.

b III

3. (Original A method for testing the performance of an oxygen sensor comprising a portion of a vehicle emission system having an on-board computer, said method comprising:

connecting a portable oxygen sensor analyzer in series with said oxygen sensor and said on-board computer, said oxygen sensor analyzer comprising a plurality of keys and indicator lights disposed thereon, and circuitry permitting the testing of said oxygen sensor in a plurality of different operating modes, said circuitry including a comparator for driving a plurality of display lights arranged in sequence to show the relative fuel/air mixture being detected in the engine in real time during a test procedure;

activating said oxygen sensor analyzer to operate in one of said operating modes to evaluate said oxygen sensor; and

evaluating the performance of said oxygen sensor by referencing the status of the indicator lights on said analyzer.

b I

4. (New) An oxygen sensor analyzer for use in testing the performance of an oxygen sensor comprising a portion of a vehicle emission system having an on-board computer, the oxygen sensor analyzer comprising:

(a) an electronic circuit having an oxygen sensor input for receiving an oxygen sensor signal from the oxygen sensor with the oxygen sensor disconnected from the on-board computer, a simulate output for connection to the on-board computer in place of the oxygen sensor, and logic means operative for driving the simulate output in:

(i) a closed-loop mode wherein the simulate output directly follows the oxygen sensor input; and

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(ii) a simulate mode wherein the simulate output, being isolated from the oxygen sensor input, is driven in an arbitrary manner for forcing the engine to run one or both of lean by driving the simulate output to simulate a rich indication from the oxygen sensor, and rich by driving the simulate output to simulate a lean indication from the oxygen sensor; and
a display for indicating the oxygen sensor signal.

5. (New) The oxygen sensor analyzer of claim 4, wherein the logic means is further operative for:

(a) driving the simulate output in a test mode wherein the simulate output, being isolated from the oxygen sensor input, is driven in a predetermined manner that includes forcing the engine to run lean by driving the simulate output to simulate a rich indication from the oxygen sensor; and

(b) monitoring the oxygen sensor input to measure time-response thereof between conditions of the engine running lean and running rich.

6. (New) The oxygen sensor analyzer of claim 5, wherein the logic means is further operative for signaling a ready condition in the test mode wherein the oxygen sensor input is indicative of the engine having reached a stable lean operating condition, and subsequently enabling the measure of time response when the oxygen sensor input is indicative of engine operation passing from lean toward rich.

7. (New) The oxygen sensor analyzer of claim 6, wherein the oxygen sensor input is responsive over a voltage range including a first predetermined value representing a lean operating condition of the engine, the signaling of the ready condition being inhibited until the sensor input maintains for a predetermined period of time a voltage representing a more lean

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operating condition than that represented by the first predetermined value.

8. (New) The oxygen sensor analyzer of claim 7, wherein the voltage range is from approximately 0 V representing a most lean operating condition of the engine to approximately 1 V representing a most rich operating condition of the engine, the first predetermined value being approximately 175 mV.

9. (New) The oxygen sensor analyzer of claim 5, wherein the electronic circuit comprises a timer for measuring a passing interval within which the oxygen sensor input changes from a first predetermined value representing a lean operating condition of the engine to a second predetermined value representing a rich operating condition of the engine, the electronic circuit being operative to signal a passing condition only if the oxygen sensor input reaches the second predetermined value within a predetermined period of time.

10. (New) The oxygen sensor analyzer of claim 4, wherein the display comprises a plurality of indicators, each of the indicators being activated by the electronic circuit continuously in response to the oxygen sensor input in accordance with a predetermined range of the oxygen sensor signal.

11. (New) The oxygen sensor analyzer of claim 10, wherein the oxygen sensor input is responsive over a voltage range of approximately 1 volt and at least one of the indicators is activated when the oxygen sensor input is within the voltage range.

6.11 12. (New) A portable oxygen sensor analyzer for use in testing the performance of an oxygen sensor comprising a portion of a vehicle emission system having an on-board computer, the oxygen sensor analyzer comprising:

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(a) an electronic circuit having an oxygen sensor input for receiving an oxygen sensor signal from the oxygen sensor, with the oxygen sensor disconnected from the on-board computer, over a voltage range of from approximately 0 V representing a most lean operating condition of the engine to approximately 1 V representing a most rich operating condition of the engine, a simulate output for connection to the on-board computer in place of the oxygen sensor, and logic means operative for driving the simulate output in:

(i) a closed-loop mode wherein the simulate output directly follows the oxygen sensor input;

(ii) a simulate mode wherein the simulate output, being isolated from the oxygen sensor input, is driven in an arbitrary manner for forcing the engine to run one or both of lean by driving the simulate output to simulate a rich indication from the oxygen sensor, and rich by driving the simulate output to simulate a lean indication from the oxygen sensor;

(iii) a test mode wherein the simulate output, being isolated from the oxygen sensor input, is driven in a predetermined manner that includes forcing the engine to run lean by driving the simulate output to simulate a rich indication from the oxygen sensor, the logic means being further operative for signaling a ready condition after the engine reaches a stable lean operating condition as signaled by the oxygen sensor input remaining for a predetermined period of time below a first predetermined value representing a lean operating condition of the engine, and subsequently monitoring the oxygen sensor input to measure time-response thereof between conditions of the engine running lean as signaled by the oxygen sensor input passing the first predetermined value and running rich as signaled by the oxygen sensor reaching a second predetermined value being higher than the first predetermined value; and

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(b) a display for continuously indicating the oxygen sensor signal.

13. (New) The oxygen sensor analyzer of claim 12, wherein the first predetermined value is approximately 175 mV and the second predetermined value is approximately 800 mV.

14. (New) A method for testing the performance of an oxygen sensor comprising a portion of a vehicle emission system having an on-board computer, the method comprising:

(a) providing an analyzer comprising an electronic circuit having an oxygen sensor input and a simulate output;

(b) connecting the analyzer in series between the oxygen sensor and the on-board computer with the oxygen sensor feeding the oxygen sensor input and the simulate output feeding the on-board computer;

(c) driving the simulate output in an arbitrary manner for forcing the engine to run one or both of lean by driving the simulate output to simulate a rich indication from the oxygen sensor, and rich by driving the simulate output to simulate a lean indication from the oxygen sensor; and monitoring the oxygen sensor input for responses to the driving of the simulate output.

15. (New) The method of claim 14, further comprising driving the simulate output in correspondence with signals received at the oxygen sensor input from the oxygen sensor to produce closed-loop operation of the engine.

16. (New) The method of claim 14, further comprising driving the simulate output in a predetermined manner that includes forcing the engine to run lean by driving the simulate output to simulate a rich indication from the oxygen sensor, wherein the monitoring of the oxygen sensor input comprises

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measuring a time-response of the oxygen sensor input between conditions of the engine running lean and running rich.

17. (New) The method of claim 16, further comprising signaling a ready condition after the engine reaches a stable lean operating condition, wherein the measuring of the time response of the oxygen sensor input is when the oxygen sensor input is indicative of engine operation passing from lean toward rich subsequent to the signaling of the ready condition.

18. (New) The method of claim 17, wherein the emission system is connected on an engine having a throttle in an intake passage for controlling engine output, the method further comprising, following the signaling of the stable lean operating condition, snapping the throttle and/or momentarily introducing a fluidic fuel into the intake passage for producing the running rich condition.